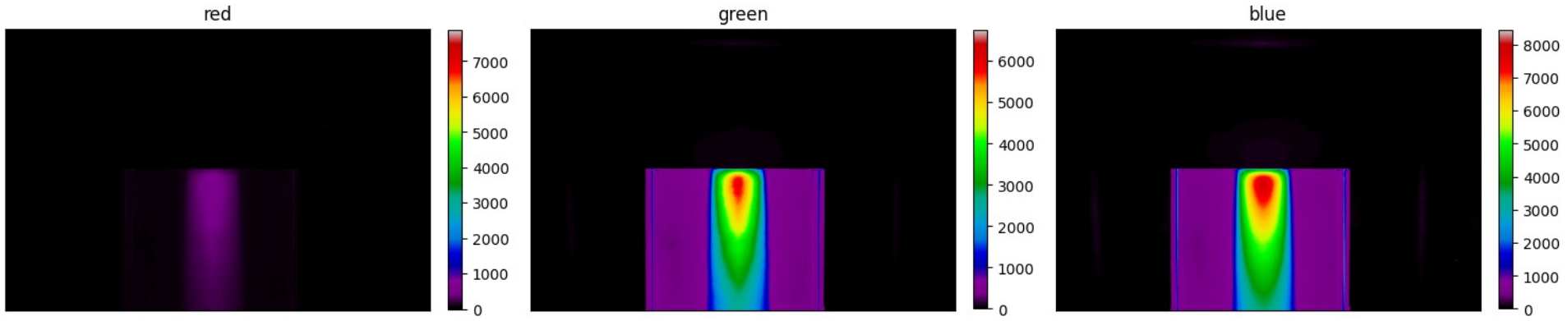
Summary of experimental procedures:

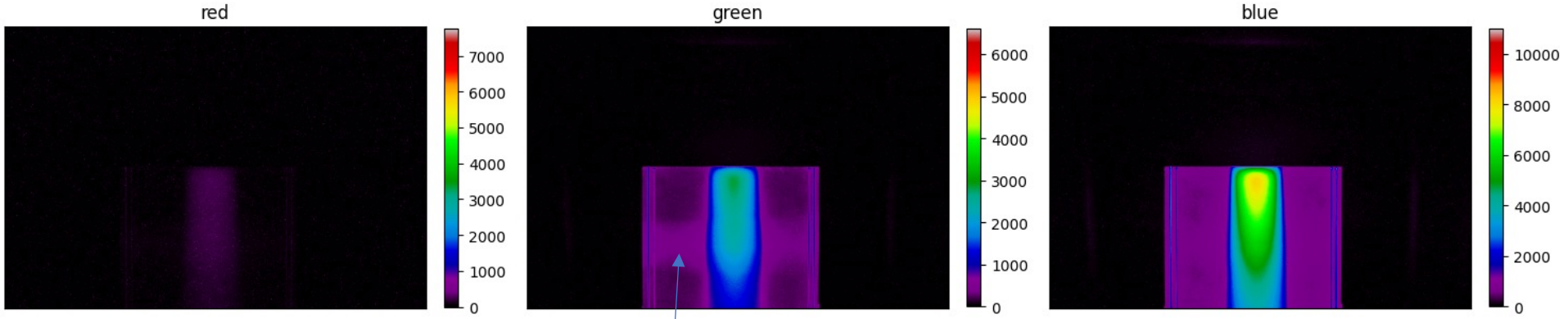
1. Checked for saturation in the 60mm and then 5mm – used 400 ISO with different exposure times for each field size
2. Took images starting from 5mm – 60mm collimators with green 2mm sheet and Geoff's blocks. (1st batch)
3. Took image without sheet and realized green discoloration shadow in the plastic block/green sheet?, then box was accidentally budged.
4. Replaced Geoff's plastic blocks with Simon's and started again.
5. Took images from 5mm – 60mm with and without green 2mm sheet. (2nd batch)

First batch of measurements (60mm):

With 2mm green sheet:
(Using Geoff’s plastic blocks)



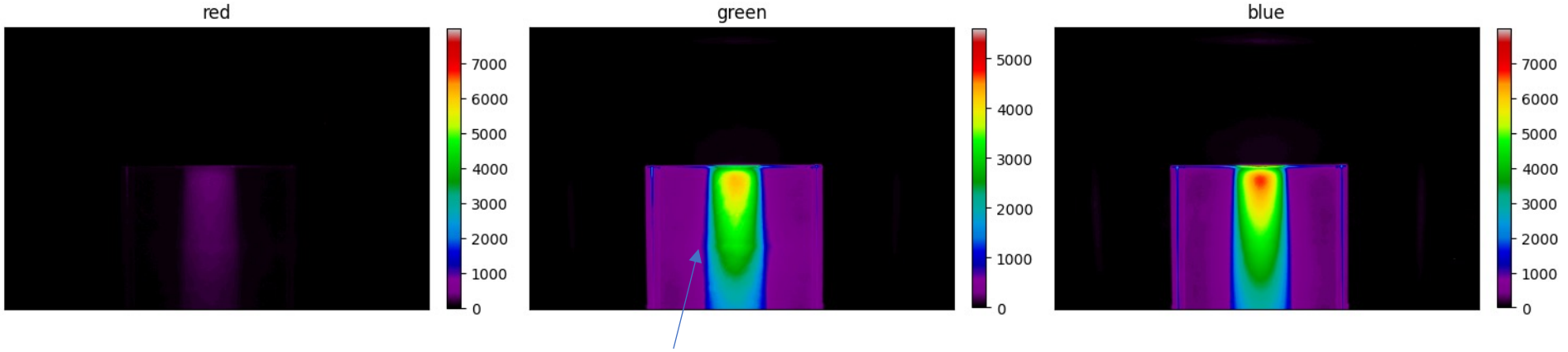
Without sheet:
(Using Geoff’s plastic blocks)



Discolouration ”shadow”

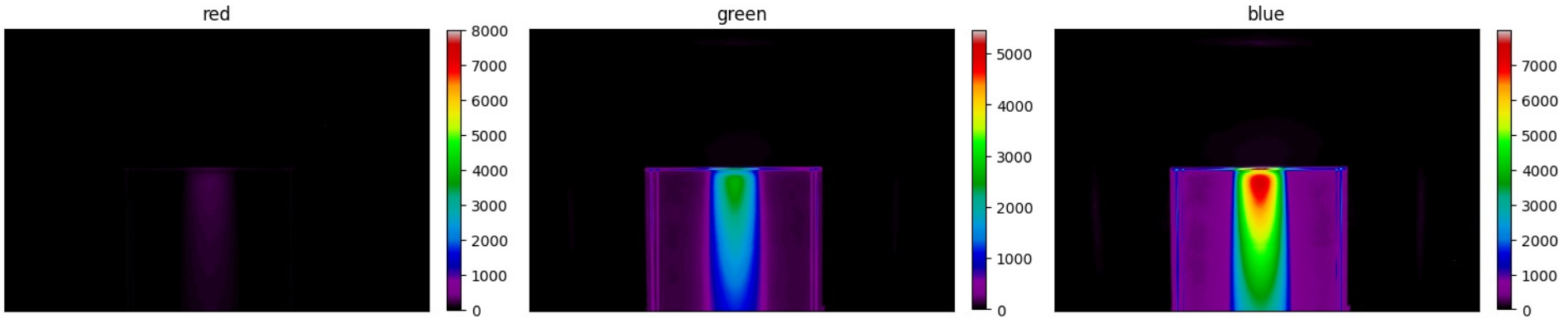
Second batch of measurements (60mm):

With 2mm green sheet:
(using Simon's plastic blocks):



Slight Horizontal discolouration

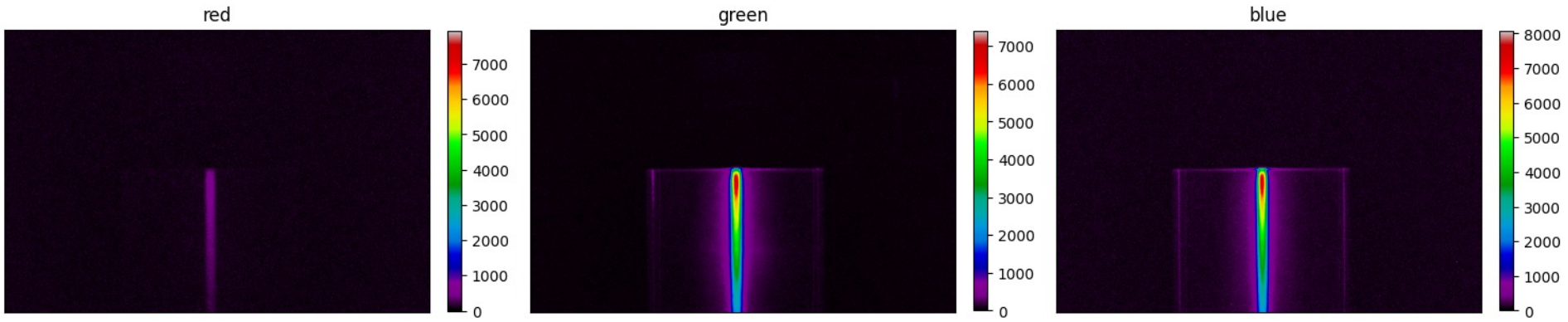
Without sheet:
(using Simon's plastic blocks)



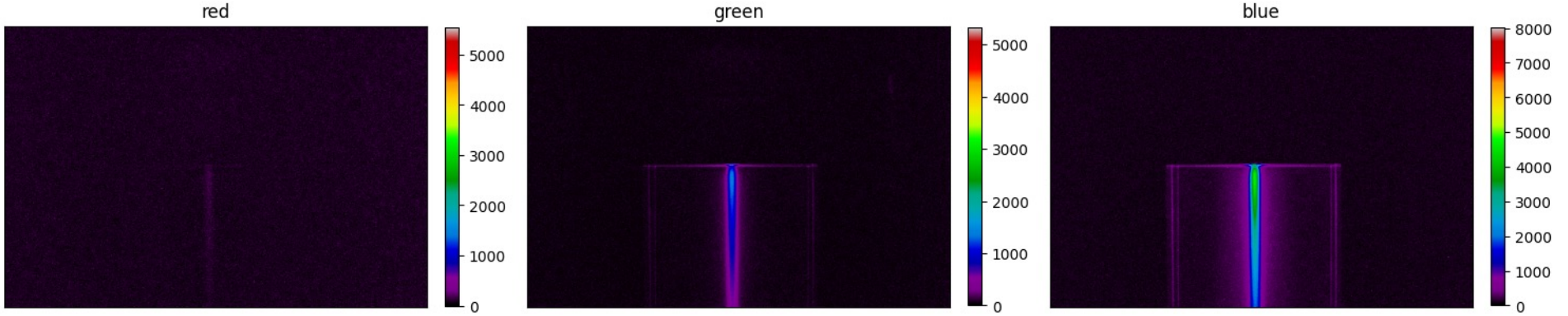
No discolouration without sheet

Second batch of measurements (10mm):

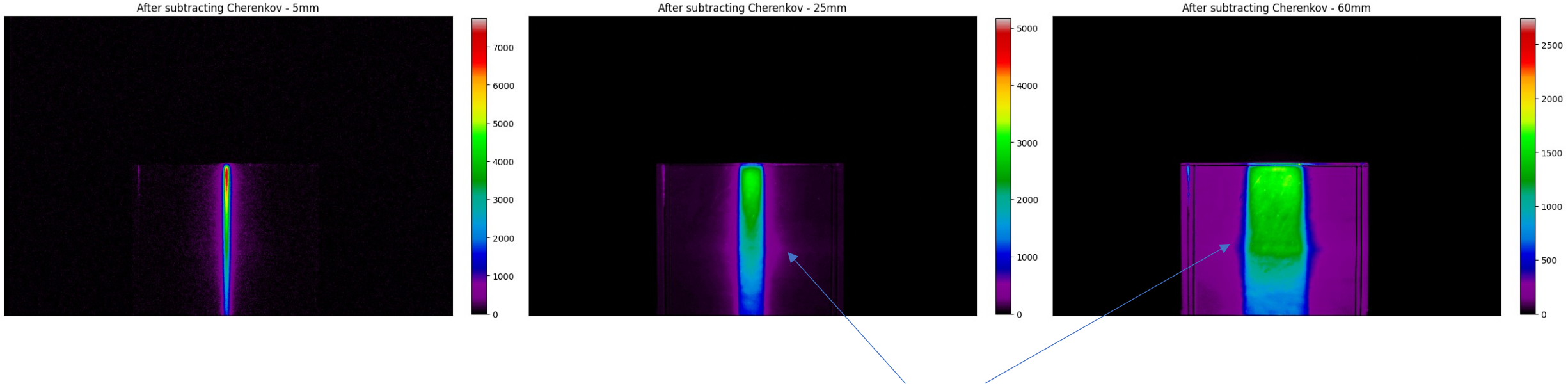
With 2mm green sheet:
(using Simon's plastic blocks):



Without sheet:
(using Simon's plastic blocks)



Cherenkov subtracted images:

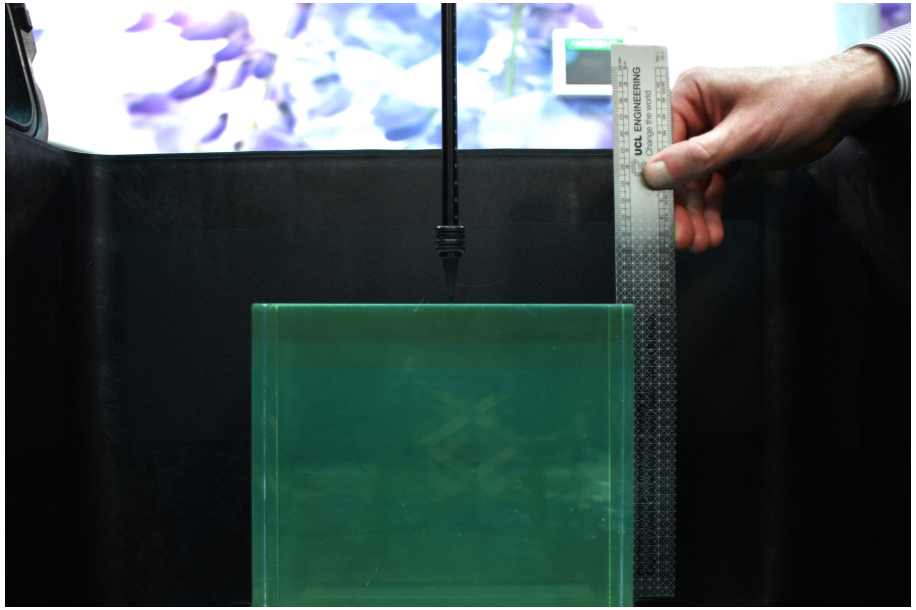


From horizontal discoloration shadow

- Used green channel
- Subtracted Cherenkov image from green sheet image
- Can see the “shadow” when there is more light

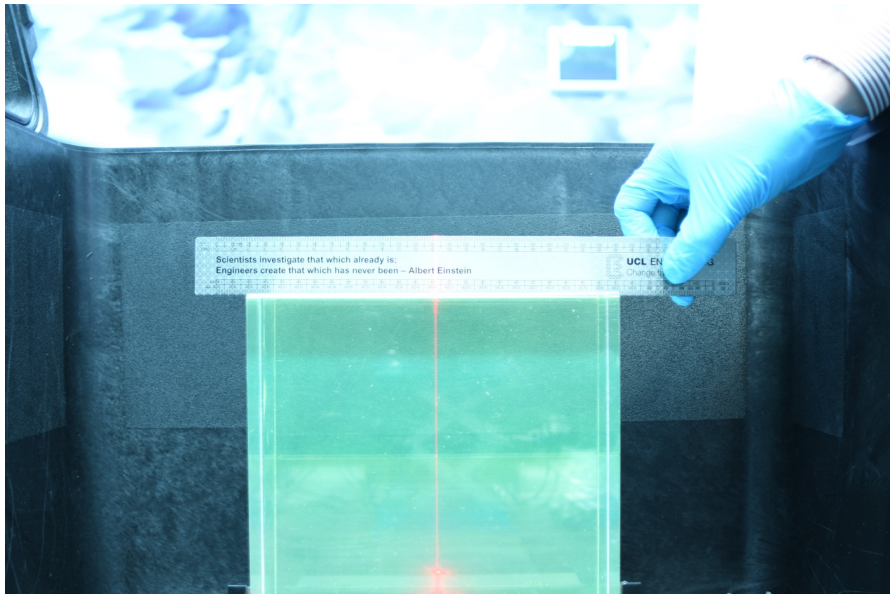
Clues to discolouration

Before 1st batch of measurements:



- Nothing has been radiated yet

Before 2nd batch of measurements:



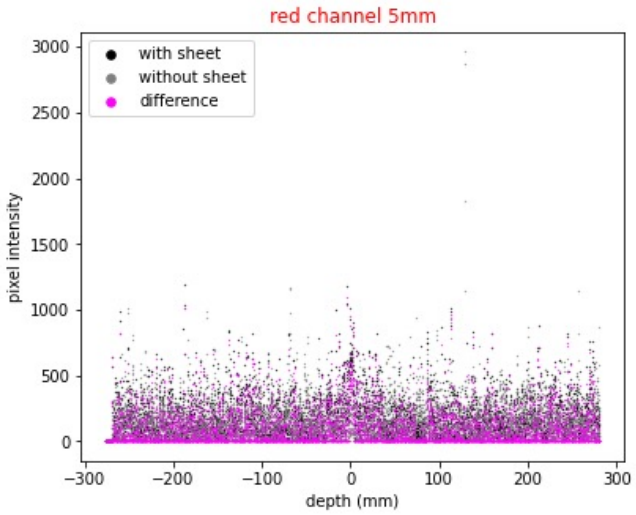
- Replaced the plastic blocks
- Only sheet has been radiated

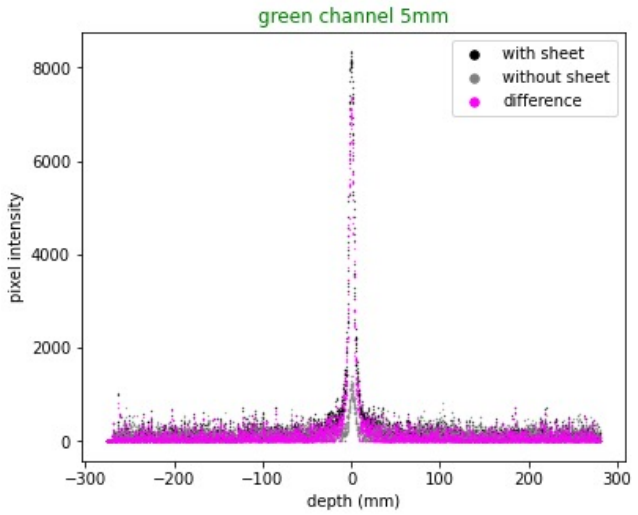
- We didn't think to take test photos of the green discolouration with the lights on after irradiation at the time. But we do have these photos before irradiation
- These photos show that there is no visible discolouration "shadow" with the lights on before irradiation. But we all saw that there was after irradiation.
- Shadow could not have been caused by the holder behind, as it was not visible in the first batch of images.

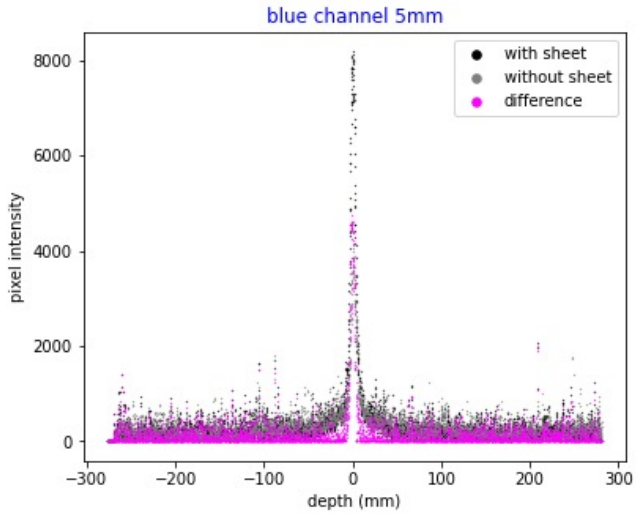
Taking a look at raw profiles/PDD

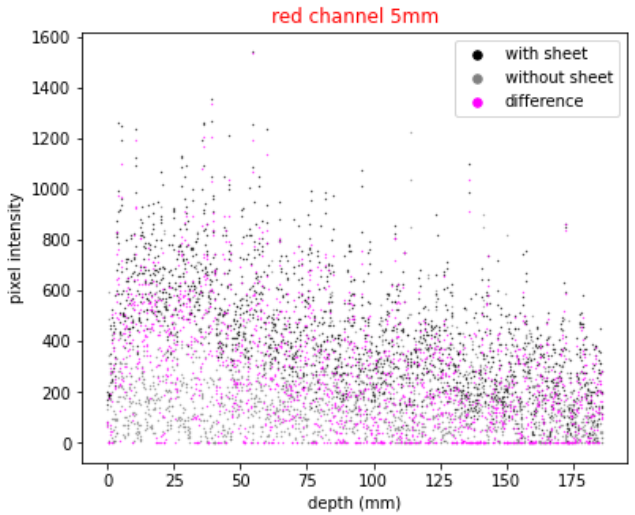
- There is little scintillation in the blue
- Roughly 60% scintillation to total light ratio in the green

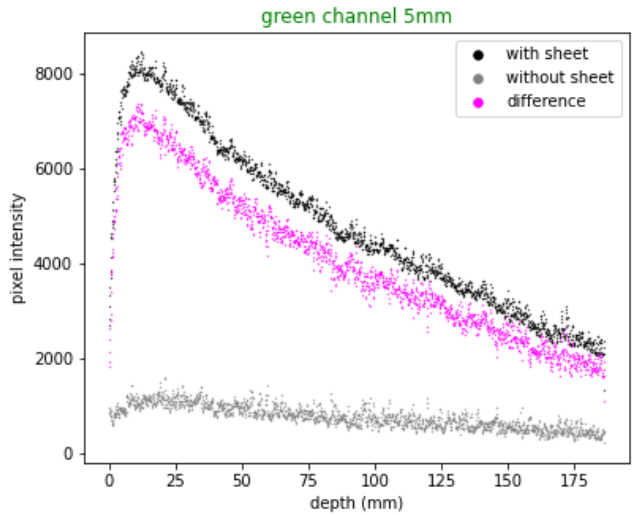
Raw RGB Profiles and PDD - 5mm

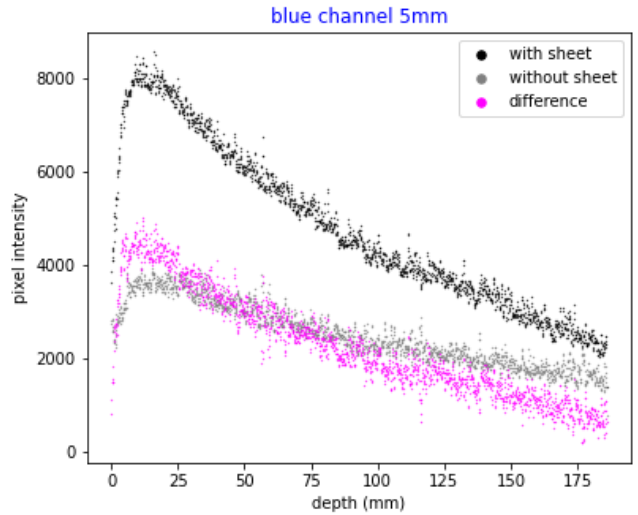












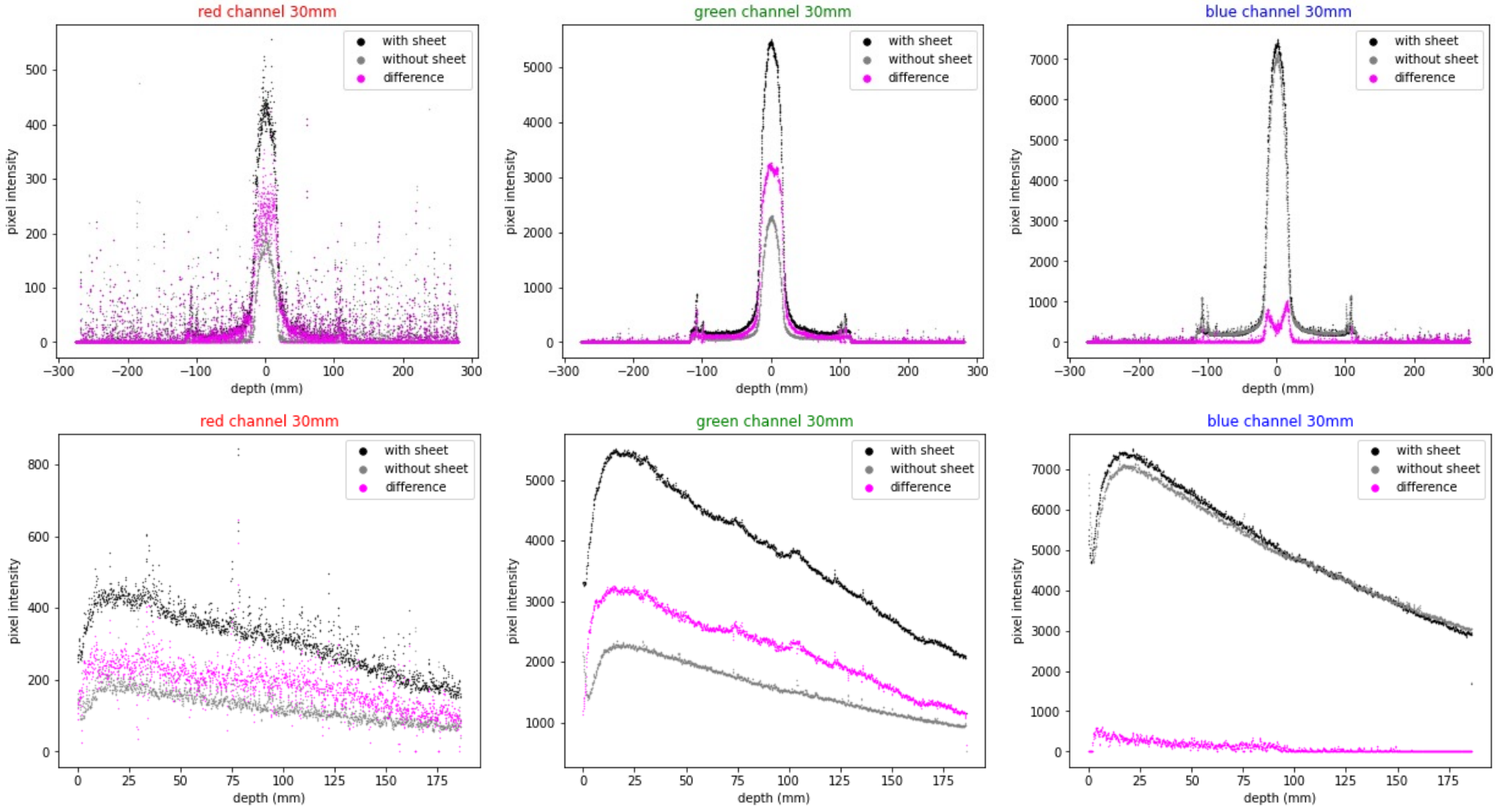
Scintillation light / Total light =
Over whole image

50%

69%

34%

Raw RGB Profiles and PDD - 30mm



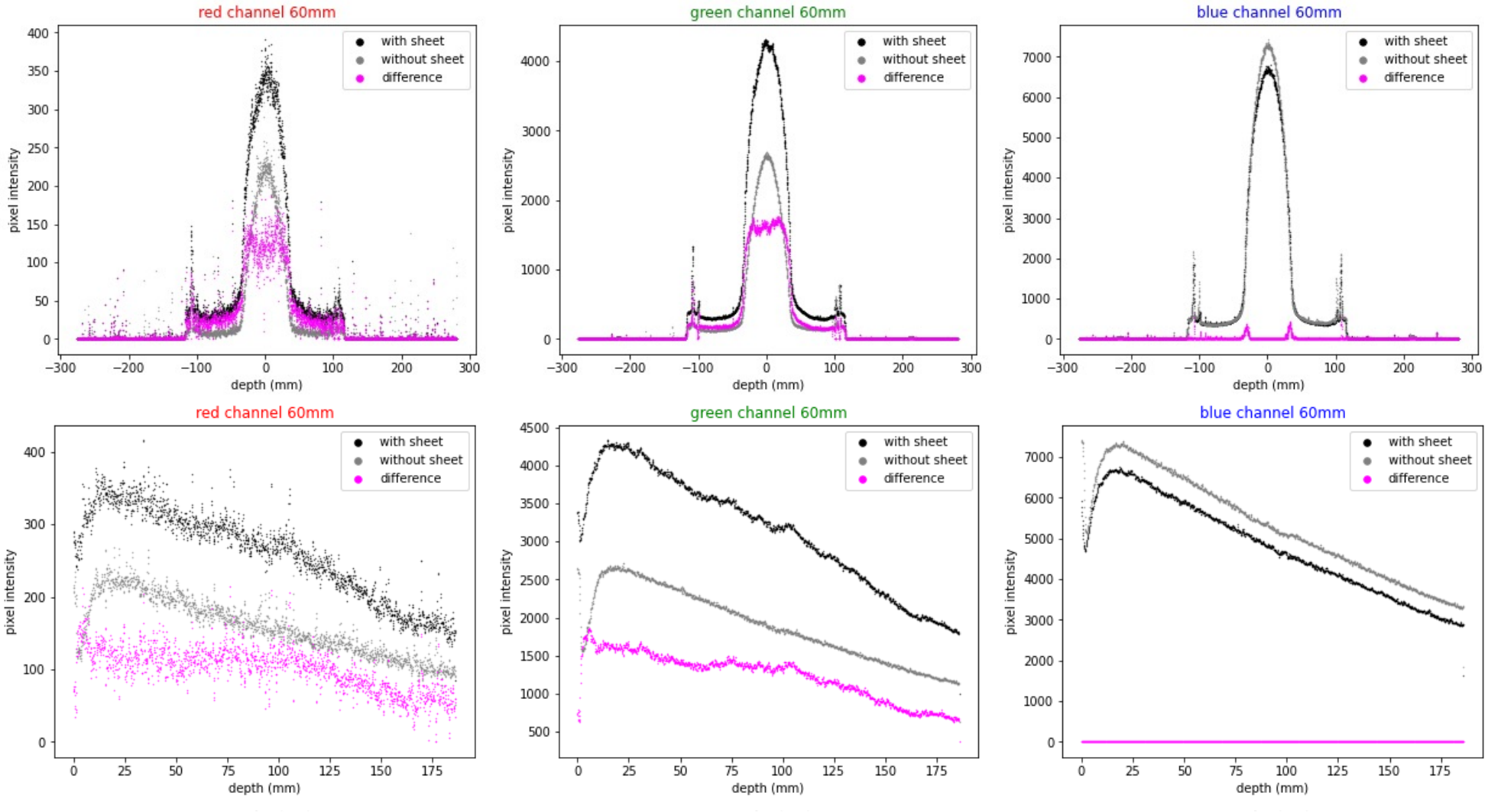
Scintillation light / Total light = Over whole image

67%

62%

5.6%

Raw RGB Profiles and PDD - 60mm



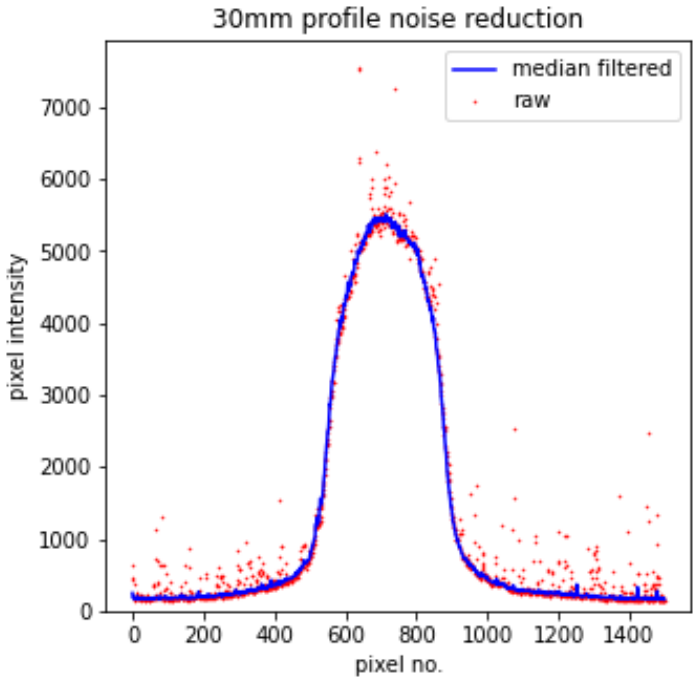
Scintillation light / Total light = 51% 48% 0.7%

Over whole image

Improving noise to signal

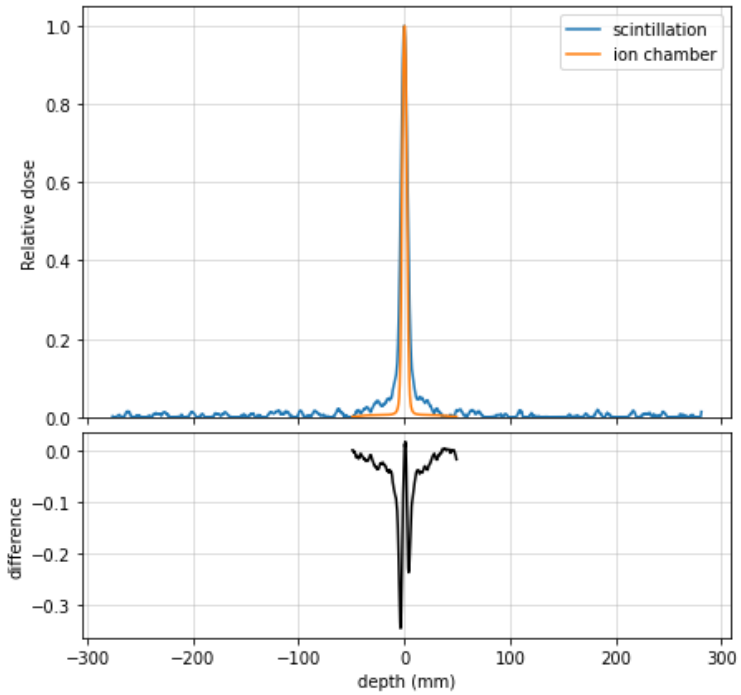
- Noise to signal = |true signal – signal|/true signal
- Where true signal is a fitted signal
- Comparison of noise reduction method:

Image processing	Mean noise to signal ratio
Raw	0.24
Mean over 5 images	0.15
Median over 5 images	0.06
3x3 median blur + mean over 5 images	0.06
3x3 median blur + median over 5 images	0.023
3x3 median blur + minimum over 5 images (works since noise is mostly additive spikes)	0.021

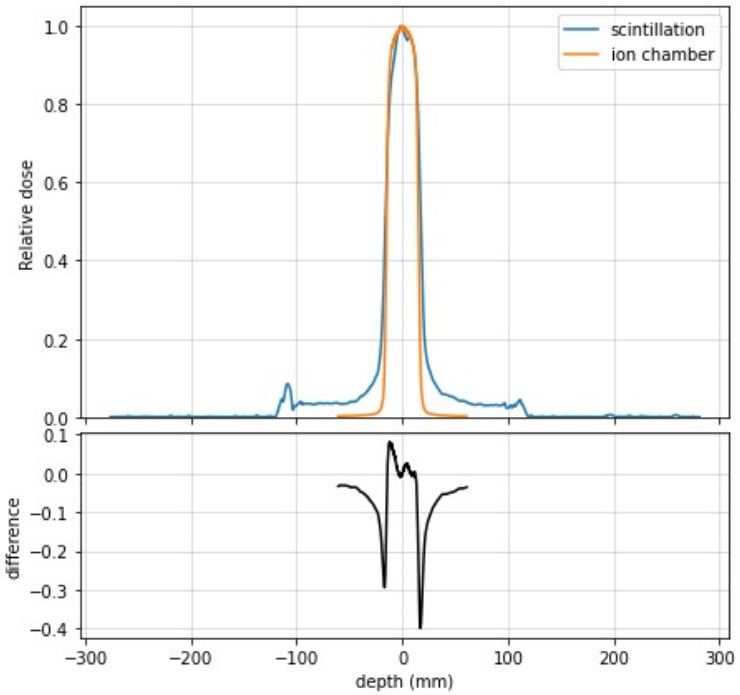


Profiles: Cherenkov subtracted

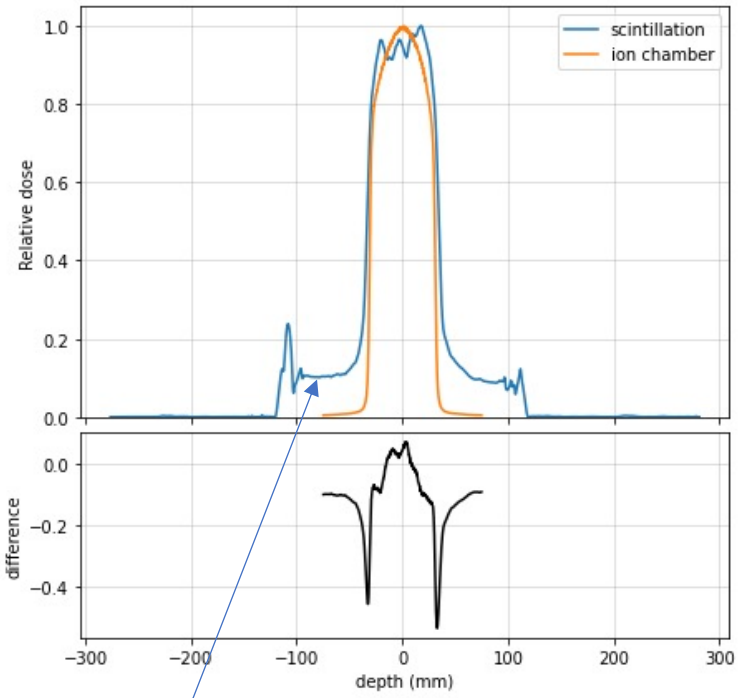
5mm



30mm



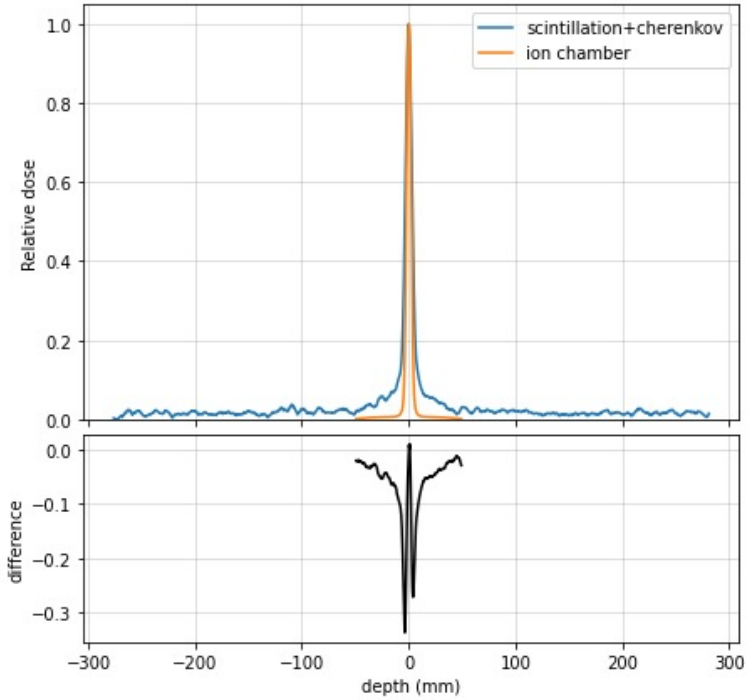
60mm



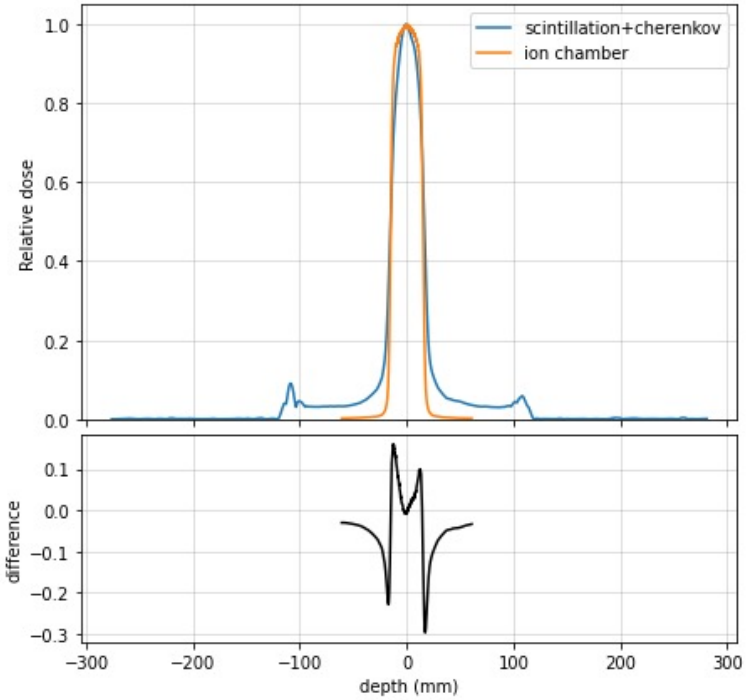
- Profiles taken at 15mm deep
- There is more light for the 60mm which means more background light – the physics of where this originates isn't understood, but we know it is coming from the plastic block/sheet as surrounding light is zero in the images.
- Used Savgol filter to smooth scintillation curve – cubic Polynomial fitted in a window size 100 pixels, window is slided across whole curve.

Profiles: Not Cherenkov subtracted

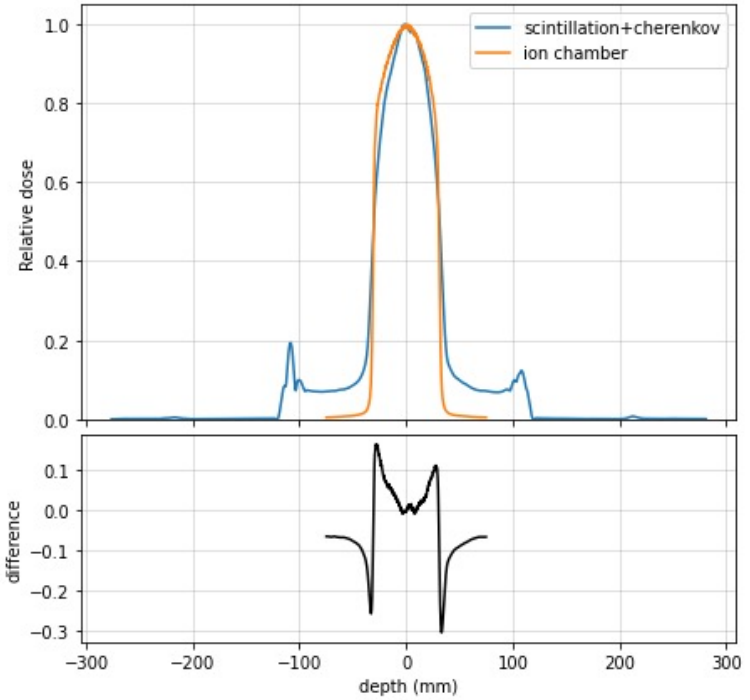
5mm



30mm

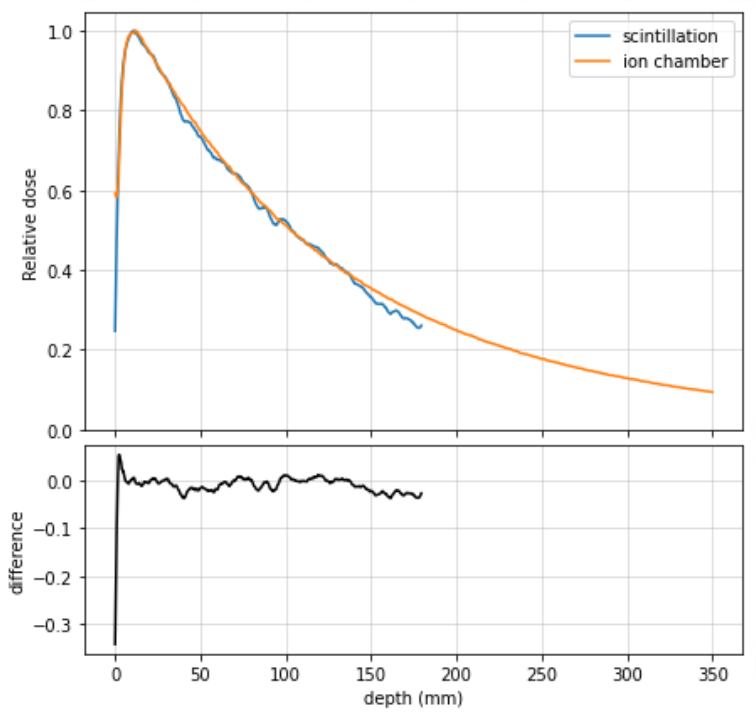


60mm

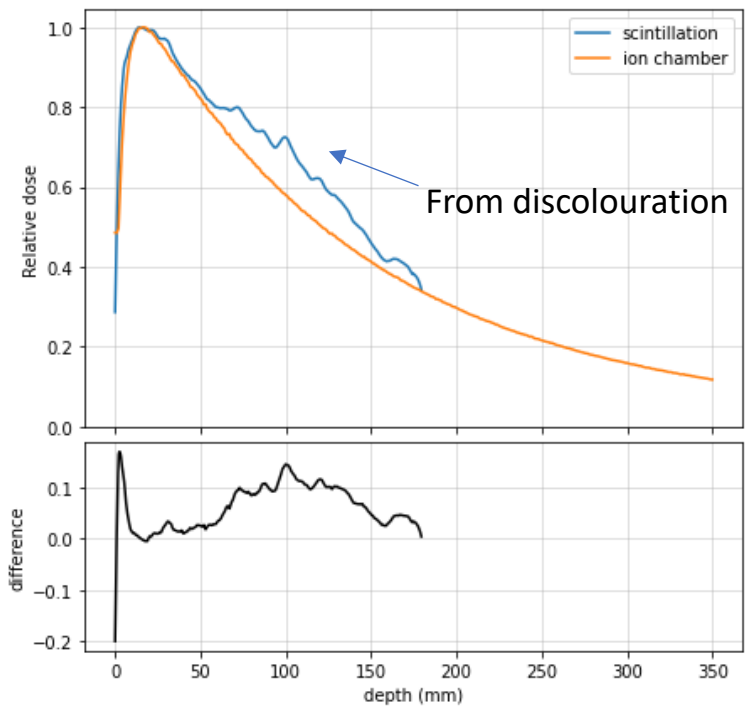


PDDs: Cherenkov subtracted

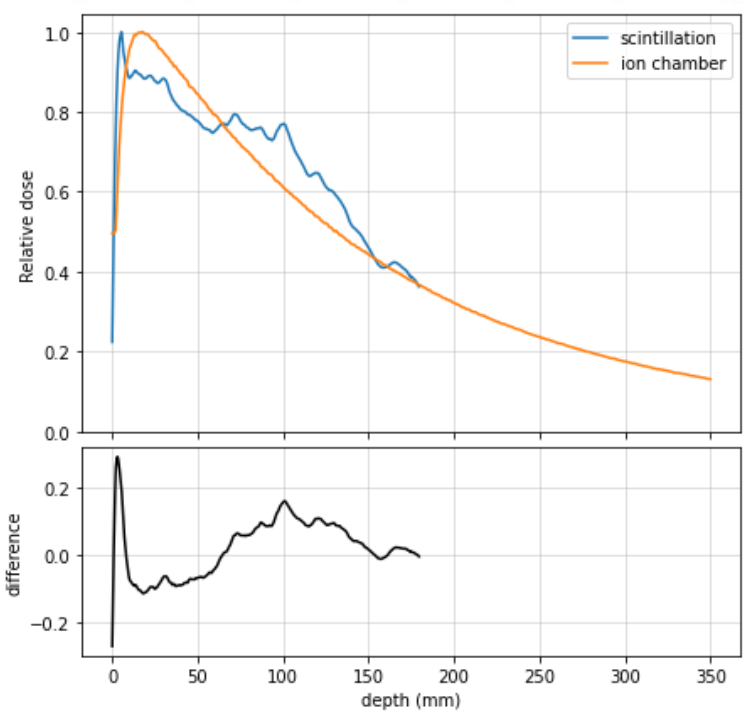
5mm



30mm



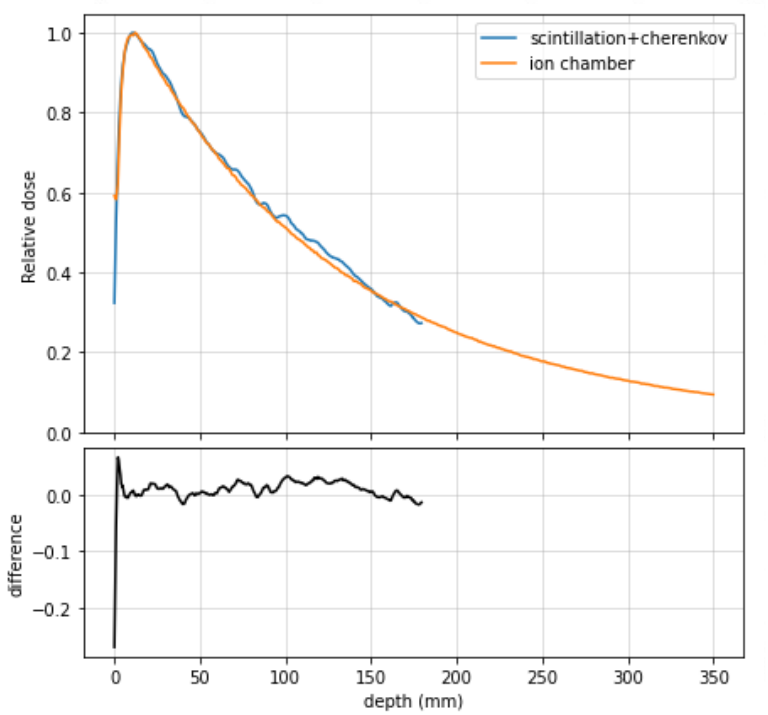
60mm



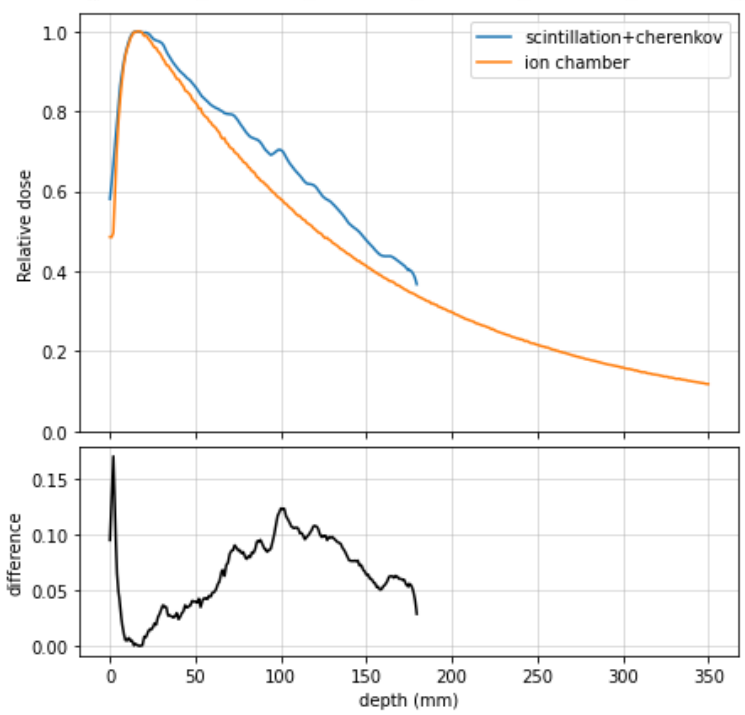
- Taken from slice down the middle of image, at profile centre.
- Corrected for apparent depth caused by refractive index.

PDDs: Not Cherenkov subtracted

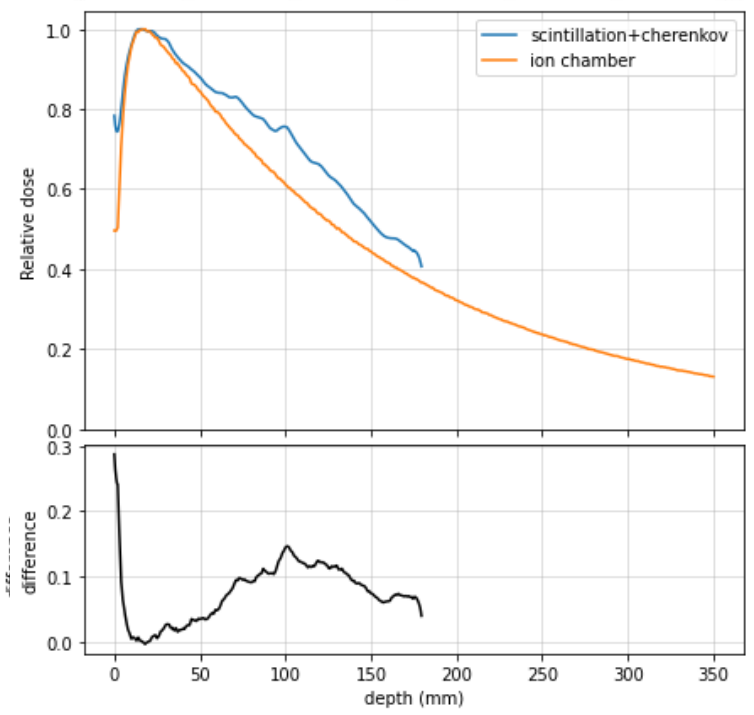
5mm



30mm

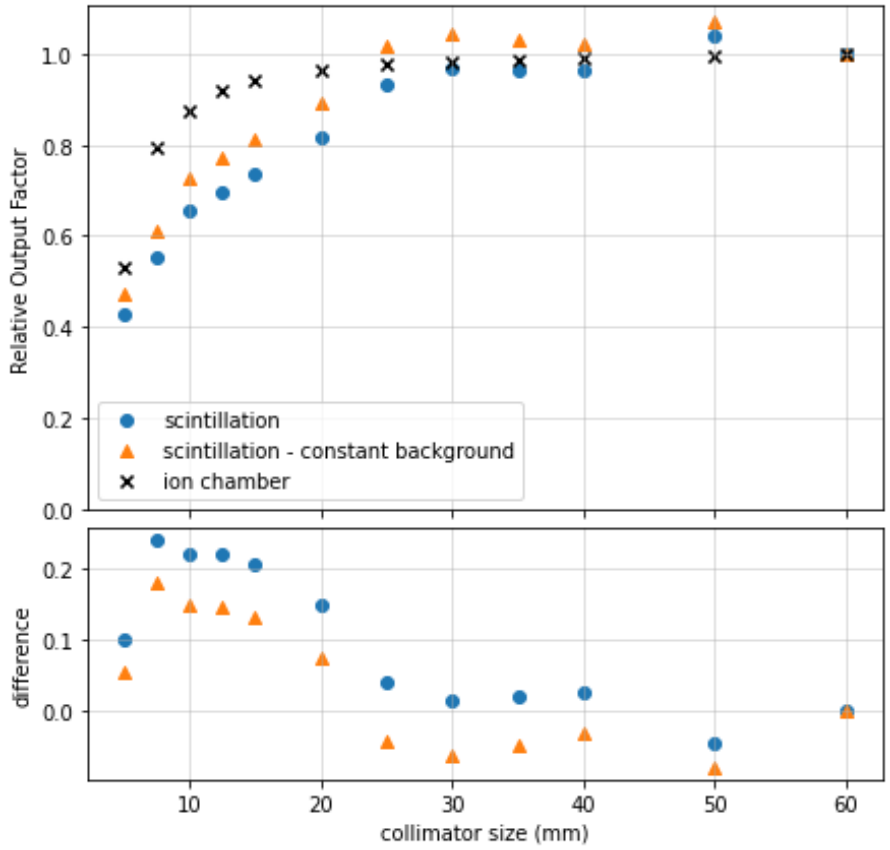


60mm

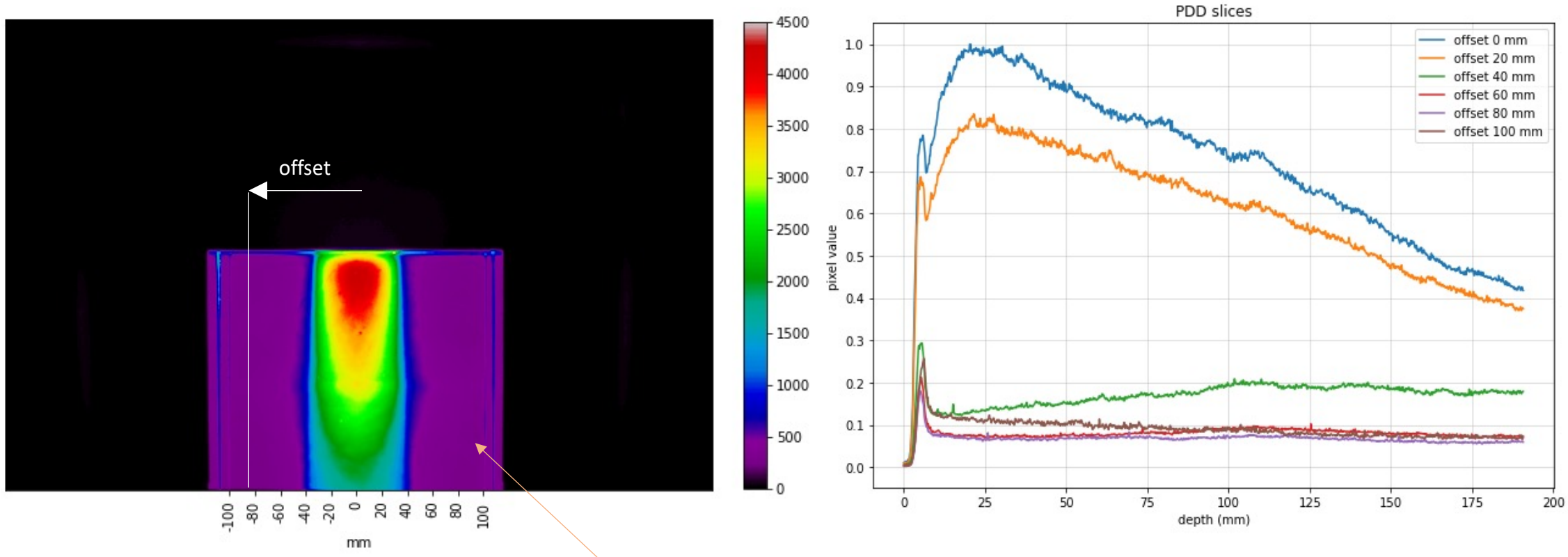


Output factor

- Taken at 15mm real depth
- Averaged over a box of pixels 1x1mm wide
- Divided by the OF of the 60mm
- The scintillation OFs are a lot lower than expected for smaller field sizes – this is presumably due to more background light for higher field sizes (slide 5)
- We can attempt to correct it by subtracting the average background glow (scintillation – constant background)

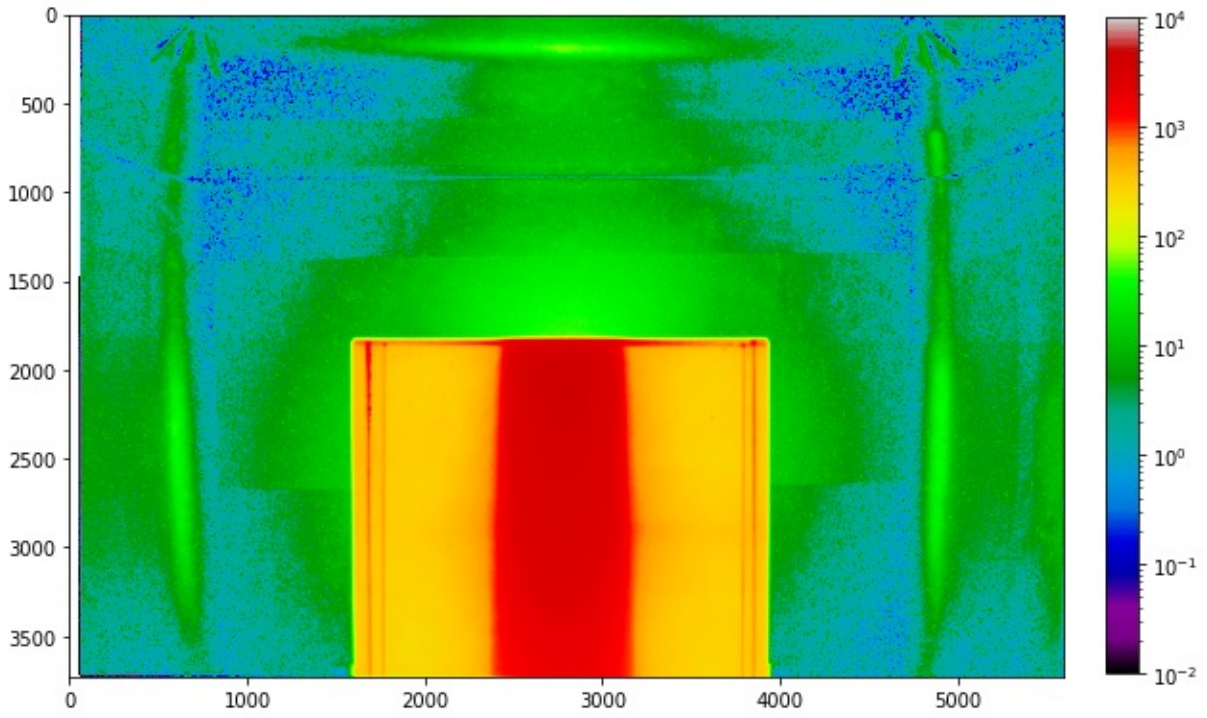


Background light in plastic



- There is optical scattering in plastic outside beam (unknown physical process)
- Take slices outside beam and plot PDD at an offset to view background levels
- Should be zero dose outside beam according to profile of ion chamber ((slide 16)
- The background light is approximately constant outside beam

Reflections from walls



- Take log scale of image
- Reflections from wall are ~ 10^3 less light output than the beam

Summary

- We know that discolouration happens after radiation and goes away after more than a few hours.
- Presumably the green sheet also gets discoloured since it's made of the same plastic base and the horizontal discolouration is not visible when the sheet is removed (2nd batch of measurements). This needs stronger evidence and we should test this next time.
- The PDD/Profiles are affected by ~10% from the discolouration (slide 14)
- There are two problems we need to solve before going to Birmingham again: The discolouration, and the background "glow" (slide 8).